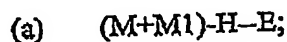


What is claimed is:

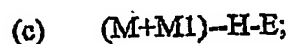
1. A composition of matter having an atomic co-ordination characterized by one of the following structural formulae:



or



or



or



wherein:

M is a metal or metalloid, or an alloy thereof, or a compound thereof;

M1 is an optional metal different from M, or an alloy thereof, or a compound thereof;

H is hydrogen;

E is an electronegative element; and

hydrogen bonding exists between H and E in structural formulae (a) and (b), and between M and H in structural formulae (c) and (d).

2. The composition of matter defined in Claim 1, wherein M comprises a first combination of at least two of the metal or metalloid, or the alloy thereof, or the compound thereof.

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3. The composition of matter defined in Claim 2, wherein the first combination is homogeneous.
4. The composition of matter defined in Claim 2, wherein the first combination is inhomogeneous.
5. The composition of matter defined in Any one of Claims 1-4, wherein M1 comprises a second combination of at least two of the metal or metalloid, or the alloy thereof, or the compound thereof.
6. The composition of matter defined in Claim 5, wherein the second combination is homogeneous.
7. The composition of matter defined in Claim 5, wherein the second combination is inhomogeneous.
8. The composition of matter defined in Any one of Claims 1-7, wherein M is selected from the group consisting of Li, Na, K, Be, Mg, Ca, Y, Sc, Ti, Zr, Hf, V, Nb, Ta, Pt, Pd, Ru, Rh, Ge, Ga, In, La, Ce, Pr, Nd, Dy, Al, Si, and B.
9. The composition of matter defined in Any one of Claims 1-7, wherein M comprises Ti.
10. The composition of matter defined in Any one of Claims 1-7, wherein M comprises Zr.
11. The composition of matter defined in Any one of Claims 1-10, wherein M1 is selected from the group consisting of Cr, Mo, W, Mn, Fe, Co, Ir, Ni, Cu, Ag, Au, Zn, Sn, Pb, Sb, and Bi.
12. The composition of matter defined in Any one of Claims 1-10, wherein M1 comprises Cu.

13. The composition of matter defined in Any one of Claims 1-12, wherein E is selected from the group comprising O, F, N, Cl, S, P, C, Te, I, Br and compounds thereof.
14. The composition of matter defined in Claim 13, wherein said compounds thereof are selected from the group comprising oxides (e.g., CuO, MgO, NiO, MnO, FeO), nitrides, halides, sulphides and tellurides, phosphides.
15. The composition of matter defined in Claim 13, wherein said compounds thereof are selected from CO and NO.
16. The composition of matter defined in Claim 13, wherein said compounds thereof comprise compounds coordinated with hydrogen atoms.
17. The composition of matter defined in Claim 16, wherein said compounds thereof coordinated with hydrogen atoms are selected from the group comprising water, hydroxides, phenols, alcohols, salts, acids, alkoxides, thiols, organic acids, salts of organic acids, acid amides, amines, acid halides, alkyl halides, sulphones, and organometallics.
18. The composition of matter defined in Any one of Claims 1-17, in particulate form.
19. The composition of matter defined in Claim 18, wherein said particulate form comprises particles having a size less than 100 microns.
20. The composition of matter defined in Claim 18, wherein said particulate form comprises 80% particles having a size less than 50 microns.
21. The composition of matter defined in Claim 18, wherein said particulate form comprises particles having a size less than 100 nm.

22. A hydrogen storage device comprising:

a metallic substance selected from the group consisting of: (a) a hydride of a metal or metalloid, or an alloy thereof, or a compound thereof, or a homogeneous or inhomogeneous combination of at least two of the metal or metalloid, the alloy thereof, or the compound thereof, or (b) a metal or metalloid capable of absorbing hydrogen to form a hydride, or an alloy thereof, or a compound thereof, or an homogeneous or inhomogeneous combination of at least two of the metal or metalloid, the alloy thereof, or the compound thereof; and

the composition of matter defined in any one of Claims 1-21.

23. The hydrogen storage device defined in Claim 22, wherein the metallic substance comprises a metal hydride.

24. The hydrogen storage device defined in Claim 23, wherein the metal hydride is selected from the group comprising vanadium hydrides, titanium hydrides and hydrides of vanadium-titanium alloys.

25. The hydrogen storage device defined in Claim 23, wherein the metal hydride comprises magnesium hydride.

26. The hydrogen storage device defined in Claim 23, wherein the metal hydride is selected from the group comprising sodium hydride and lithium hydride.

27. The hydrogen storage device defined in Claim 23, wherein the metal hydride comprises is selected from the group comprising sodium tetrahydridoaluminate and lithium tetrahydridoaluminate.

28. The hydrogen storage device defined in Claim 22, wherein the metallic substance comprises a metal capable of absorbing hydrogen to form a hydride.

29. The hydrogen storage device defined in Claim 28, wherein the metal capable of absorbing hydrogen to form a hydride comprises Ti.

30. The hydrogen storage device defined in Claim 28, wherein the metal capable of absorbing hydrogen to form a hydride comprises Zr.
31. The hydrogen storage device defined in Claim 28, wherein the metal capable of absorbing hydrogen to form a hydride comprises Nb.
32. The hydrogen storage device defined in Claim 28, wherein the metal capable of absorbing hydrogen to form a hydride comprises Mg.
33. A method for preparing the composition of matter defined in any one of Claims 1-21 comprising steps of:
- (a) combining (i) a metallic substance selected from the group consisting of a hydrogenated, metal or metalloid, or an alloy thereof, or a compound thereof, or an homogeneous or inhomogeneous combination of at least two of the hydrogenated, metal or metalloid, or the alloy thereof, or the compound thereof, with (ii) a source of an electronegative element, to form a first intermediate; and
  - (b) milling the first intermediate to effect reaction between the metallic substance and the electronegative element.
34. The method defined in Claim 33, wherein Step (b) is carried out in a substantially inert environment.
35. The method defined in any one of Claims 33-34, wherein Step (b) is carried out in a gaseous environment having an insufficient concentration of a reducing agent to effect deleterious reduction of the intermediate product.
36. The method defined in any one of Claims 33-35, wherein Step (b) is carried out in a high energy ball mill.
37. The method defined in any one of Claims 33-36, wherein Step (b) is carried out in the presence of a liquid.

38. The method defined in Claim 37, wherein the liquid is selected from water, alcohol and mixtures thereof.
39. The method defined in any one of Claims 37-38, wherein the molar ratio of the liquid to the metallic substance is less than 1:1.
40. The method defined in any one of Claims 33-36, wherein Step (b) comprises milling the metallic substance with a gaseous reagent.
41. The method defined in Claim 40, wherein the gaseous reagent is selected from the group comprising hydrogen, oxygen, chlorine, fluorine and nitrogen.
42. The method defined in any one of Claims 33-36, wherein Step (b) comprises milling the metallic substance with a solid reagent.
43. The method defined in Claim 42, wherein the solid reagent is selected from the group comprising a solid hydrocarbon, an oxide, a chloride, a fluoride, a sulfide, a carbide, a telluride, an iodide and an alkoxide.

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